Environmental Impact of Chemical Vapour Deposited Graphene: Copper vs Nickel

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Since the celebrated mechanical exfoliation of single layer graphene using the scotch tape method in 2004, [1] significant effort has been put to develop a large-scale production route that yields high quality graphene sheets towards enabling industrial applications of this "miracle material". To that end, chemical vapour deposition (CVD) growth of graphene has emerged as a scalable route, yeilding high-quality sheets of graphene. CVD can result in either single layer (SLG) or few-layer graphene (FLG) depending on the catalyst substrate used. Despite the fact that most of the scientific foucs has been directed towards SLG, FLG has increasingly shown various advantages over SLG, such as stability and resiliance, especially in the context of flexible/stretchable devices applications. In this work, we apply life cycle assessment (LCA) methodology to compare and assess the environmental impacts of both CVD SLG grown on copper foil and FLG grown on nickel thin films, based on the standard experimental procedures currently used by the graphene community.
Following ISO 14040, all required materials and processes were compiled, and they were translated into impact category scores. The embodied energy in both materials is assessed as well, identifying the main culprit for the final cost.
The functional unit (FU) selected for this study is the widely accepted figure of merit used to rank transparent conducting electrodes. The results are expressed in units per cm^2 and units normalized to the FU.

References

[1] Novoselov, K. S. et al. Science 306, (2004) 666.

Figures

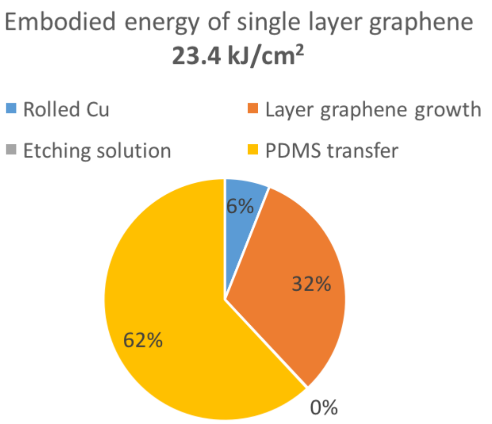

Figure 1: Embodied energy per square centimeter of SLG

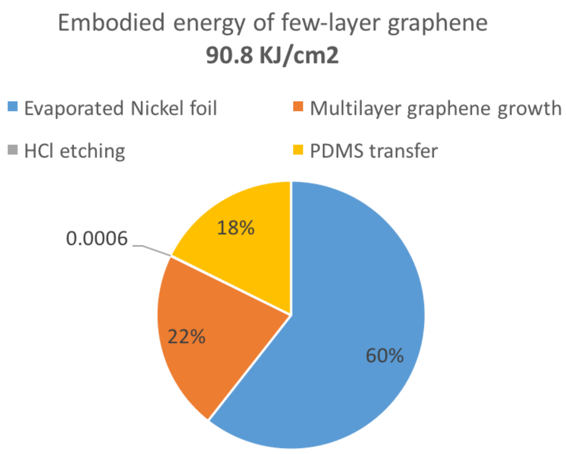

Figure 2: Embodied energy per square centimeter of FLG